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Subclinical ultrasonographic abnormalities of the suspensory ligament branches in National Hunt racehorses

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Summary

Background

Suspensory ligament branch (SLB) desmopathy is a common cause of lameness and an important cause of lost training in the Thoroughbred racing industry. Studies have assessed the impact of insertional injuries of the SLB on the careers of flat racehorses and established the prevalence of subclinical ultrasonographic SLB abnormalities in this population, but little work has investigated SLB injury in National Hunt (NH) racehorses.

Objectives

To investigate the prevalence of subclinical ultrasonographic SLB abnormalities in NH racehorses with no clinical signs or history of SLB injury and to establish the cross-sectional area (CSA) of SLBs in this population.

Study design

Cross-sectional study using data collected from horses on an NH yard.

Methods

Ultrasonographic examination of forelimb SLBs in 62 horses on a single NH yard was performed. Images were graded according to a previously reported system. CSA measurements were obtained from transverse images.

Results

Nineteen of 62 horses had at least one SLB with grade 2 ultrasonographic abnormalities. Grade 2 ultrasonographic abnormalities occurred more frequently in the medial than the lateral SLB ($P = 0.05$). The medial SLB insertional CSA was significantly larger ($P < 0.001$) than that of the lateral SLB.

Main limitations

Length of time on the yard (and therefore available veterinary history) is variable in this population.

Conclusions

One in three NH racehorses without history or clinical signs of SLB injury had at least one SLB with a grade 2 ultrasonographic abnormality. The medial branch was over-represented. The medial SLB insertional CSA is larger than the lateral and thus comparison with the corresponding branch in the contralateral limb is recommended to avoid misdiagnosis of medial SLB enlargement.

Introduction

Suspensory ligament branch (SLB) desmopathy is a common cause of lameness in horses of all athletic disciplines and an important cause of lost training days and wastage in the Thoroughbred racing industry [1-4]. Routine assessment of the SLB and the ligament–bone interface at the proximal sesamoid bone (PSB) involves ultrasonographic examination and radiography of the metacarpo(tarso)phalangeal joint [2, 5]. Magnetic resonance imaging findings associated with SLB injury have also been described [6, 7]. Ultrasonographic changes associated with SLB injury include changes in the shape of the branch, loss of margin definition, changes in echogenicity (hypoechoic areas and hyperechoic foci), periligamentous fibrosis and avulsion fractures or enthesioid new bone on the associated PSB [2, 4].

A recent study of the effects of SLB injury on the racing careers of juvenile Thoroughbreds demonstrated that horses with SLB injury started fewer races in both their 2- and 3-year-old seasons than those without [3]. Horses with mild SLB injuries performed similarly to sibling controls (those without SLB injury) in their 3-year-old seasons, but moderate to severe SLB injuries resulted in reduced performance and increased risk for re-injury. A study of flat racehorses without clinical signs or history of suspensory ligament injury identified grade 2 SLB ultrasonographic abnormalities (which the authors considered may be clinically significant or affect the sale of the horse) in 6.7% of the population [8]. Moderate lesions were identified in 22% of forelimb SLBs in a recent post-mortem study of Californian racehorses [9]. These three studies involved young flat racehorses; there are no published studies investigating SLB injury in National Hunt (NH) racehorses. The latter are generally older and tend to have longer careers than flat racehorses. Prevalences of tendon and ligament injuries have been found to increase with age in both NH and flat racehorses [10-12].

Enlargement of the SLB cross-sectional area (CSA) may be a feature of clinical SLB injury [2, 4]. The CSAs of SLBs have been established in several breeds, including Thoroughbreds in flat race training, Arabians, Icelandic ponies and Spanish horses [13-15], but there are no reports of the CSAs of SLBs in NH racehorses.

The aims of this study were to: (1) investigate the prevalence of subclinical SLB injuries in NH horses in training with no clinical signs or history of SLB injury, and (2) to establish the mean CSA of the ligament at the insertion onto the PSB in this group of horses.

Materials and methods

Training yard

Thoroughbred racehorses in training on a single large NH training yard were included in the study. The yard was selected on the basis of its location and the trainer's willingness to participate in the study. The limbs of all horses were examined and palpated daily by the assistant trainer. Veterinary attendance at the yard was regular, veterinary assessment of new horses was thorough and record-keeping of instances of suspected or confirmed musculoskeletal injury was good. Follow-up data on injuries to the suspensory apparatus were obtained from the training yard veterinary records for all horses at 8 months after examination.

Horse selection

Horses housed in consecutive stables were examined, starting from stable number 1. Horses were excluded if their yard records indicated any history of suspensory ligament injury. First, limbs were palpated carefully by one veterinarian (AJF) in both weight bearing and lifted positions; any horse with palpable enlargement or abnormality of the branches or the PSB, or which had pain on firm palpation of the ligament and insertion was excluded from the study. Information on the age, height and weight of horses was obtained from yard records. Whether

the horse had raced prior to the date of scanning and the number of career race starts to that date were noted from the Racing Post website.^{[1](#)}

Ultrasonographic method

All limbs were examined in November 2013 by a single experienced clinician (AJF) using a Logic E portable ultrasound scanner^{[2](#)} with a 6–13 MHz linear probe. A set of imaging parameters optimised for examination of the SLB in unclipped limbs had been determined prior to the study; this preset was used in all horses. All images were anonymised at acquisition and were stored on the ultrasound machine before being transferred to an OsiriX DICOM image work station^{[3](#)} prior to grading.

Horses were not clipped or sedated for the study. The distal metacarpal regions were cleaned with a dilute chlorhexidine solution and an oil emulsion was applied to the area for scanning. The distance from the suspensory bifurcation to the SLB insertion onto the PSB was determined using ultrasound examination with the horse fully and evenly bearing weight. Ten images per branch were stored. Three transverse images were obtained and stored at each of three sites: (1) at the insertion of the SLB onto the PSB; (2) at one-third of the distance from distal to proximal between the insertion and the bifurcation; and (3) at two-thirds of this distance. One longitudinal image was also obtained at the insertion of the SLB onto the PSB.

Image review

All ultrasonographic images were reviewed independently by two experienced equine clinicians (a diagnostic imaging resident [AJF] and a diplomate in both surgery and diagnostic imaging [ARSB]) to assess inter-observer agreement. The diagnostic imaging resident reviewed the images twice, on occasions 8 weeks apart, to allow an assessment of intra-observer agreement. A previously reported grading system with grades of 0–3 was used ^{[\[8\]](#)}. The presence of a fragment/mineralisation (hyperechoic areas with acoustic shadowing) within the branch, hyperechoic areas with no acoustic shadowing and PSB surface irregularity was noted. Examples of longitudinal and transverse images of all grades and abnormalities are demonstrated in Supplementary Item 1 (online). Each site within the branch was assigned a grade (based on three transverse images for the proximal two sites, and based on the longitudinal image in addition to the three transverse images for the insertional site) and an overall ‘branch grade’ was established using the highest grade assigned to that branch at any site. All CSA measurements were performed by a diagnostic imaging resident (AJF) using the built-in measuring software on the ultrasound machine. The branch was measured in each transverse image at each site and the mean for each site was calculated from the three measurements.

Data analysis

Inter-observer and intra-observer agreement in grading was assessed using a weighted kappa statistic ^{[\[16\]](#)} for grades and kappa statistics for the presence of hyperechoic areas, fragments and PSB surface irregularity. Agreement was interpreted as being slight with kappa values of 0–0.2, fair with values of 0.2–0.4, moderate with values of 0.4–0.6, good with values of 0.6–0.8 and excellent with values of 0.8–1 ^{[\[17\]](#)}. Following inter-observer agreement analysis, the images for which disagreement arose were reviewed by the observers together and consensus was reached and used for further analysis.

A Wilcoxon signed rank test was used to assess differences in grades of SLB within horses between right and left limbs and medial and lateral branches. Associations between the grade of a branch and the presence of hyperechoic areas and between the grade of the branch and PSB surface irregularity were assessed using chi-squared tests for each branch. Univariable logistic regression was used to establish whether there were associations between the horse's sex, age, height, weight, whether the horse was raced or unraced and number of career race

starts, and the presence or absence of at least one grade 2 branch abnormality recorded in the horse. Sex and raced/unraced status were treated as categorical variables, and age, height, weight and number of races were analysed as continuous variables; linear relationships were examined.

The CSA of all transverse images at all sites in five horses was measured five times each and the coefficient of variation of measurements was calculated. The mean insertional CSA was used for all statistical tests. Using the CSA measurement as the outcome, univariable linear regression models were constructed to test for associations between the horse's sex, age, height, weight, whether it was raced or unraced and number of career race starts, and the outcome of branch CSA. Spearman's rank correlation was used to assess for correlation between the grade and CSA of the branch for each branch. Differences between the mean CSAs of the branches within a horse were assessed with a within-subjects analysis of variance (ANOVA).

When tests were run on each branch, or branches were compared, in a horse, Bonferroni correction was applied. All statistical analyses were run using SPSS IBM Statistics for Windows Version 23.0.⁴ The level of significance was set at $P \leq 0.05$ for single tests and $P \leq 0.0125$ when Bonferroni correction was applied.

Results

Descriptive statistics

In total, 67 horses were examined; two were excluded because they indicated pain on palpation of a suspensory branch and a further three horses were excluded during the ultrasonographic examination because the images obtained were of very poor quality. The remaining 62 horses comprised 53 geldings and nine mares. The median age was 5 years (range: 3–12 years; interquartile range [IQR]: 2 years). Median height and mean \pm s.d. weight were 163 cm (range: 158–173 cm; IQR: 2) and 481.00 ± 31.23 kg (range: 410–564 kg), respectively. All horses were in full training at the time of the study; 12 were unraced and 50 horses were raced; the median number of starts of those that had raced was eight (range: 1–44 races; IQR: 13.5). The median time at the yard was 342 days (range: 9–2004 days; IQR: 482).

Observer agreement

The grades assigned by each observer are shown in Table 1. There was grading agreement between observers in 216 of 248 SLBs and the inter-observer agreement was good (weighted $\kappa = 0.78$). Intra-observer agreement was excellent (weighted $\kappa = 0.83$). One fragment was identified within the ligament insertion onto the sesamoid bone and intra/inter-observer agreement on the presence/absence of a fragment was perfect ($\kappa = 1.00$). Agreement on the presence of hyperechoic areas at the insertion was moderate ($\kappa = 0.51$). There was excellent inter-observer agreement on the presence of irregularity of the PSB surface ($\kappa = 0.86$).

Table 1. Grades assigned by each of two observers to suspensory ligament branches in a population of 62 National Hunt racehorses without history or clinical signs of suspensory ligament injury

		Observer 2			
		Grade 0, n	Grade 1, n	Grade 2, n	Total, n
Observer 1	Grade 0, n	52	8	0	60
	Grade 1, n	20	138	2	160
	Grade 2, n	0	2	26	28
	Total, n	72	148	28	248

Grades

Following a consensus review of the images for which disagreement had occurred, one further branch was assigned to grade 2, which resulted in consensus on 27 grade 2 SLBs (Figs [1](#), [2](#)). No branch was graded as grade 3 by either observer. Following consensus review, 58 and 163 SLBs were graded as representing grades 0 and 1, respectively (Fig [3](#)). Consensus grades were used for further statistical analysis.

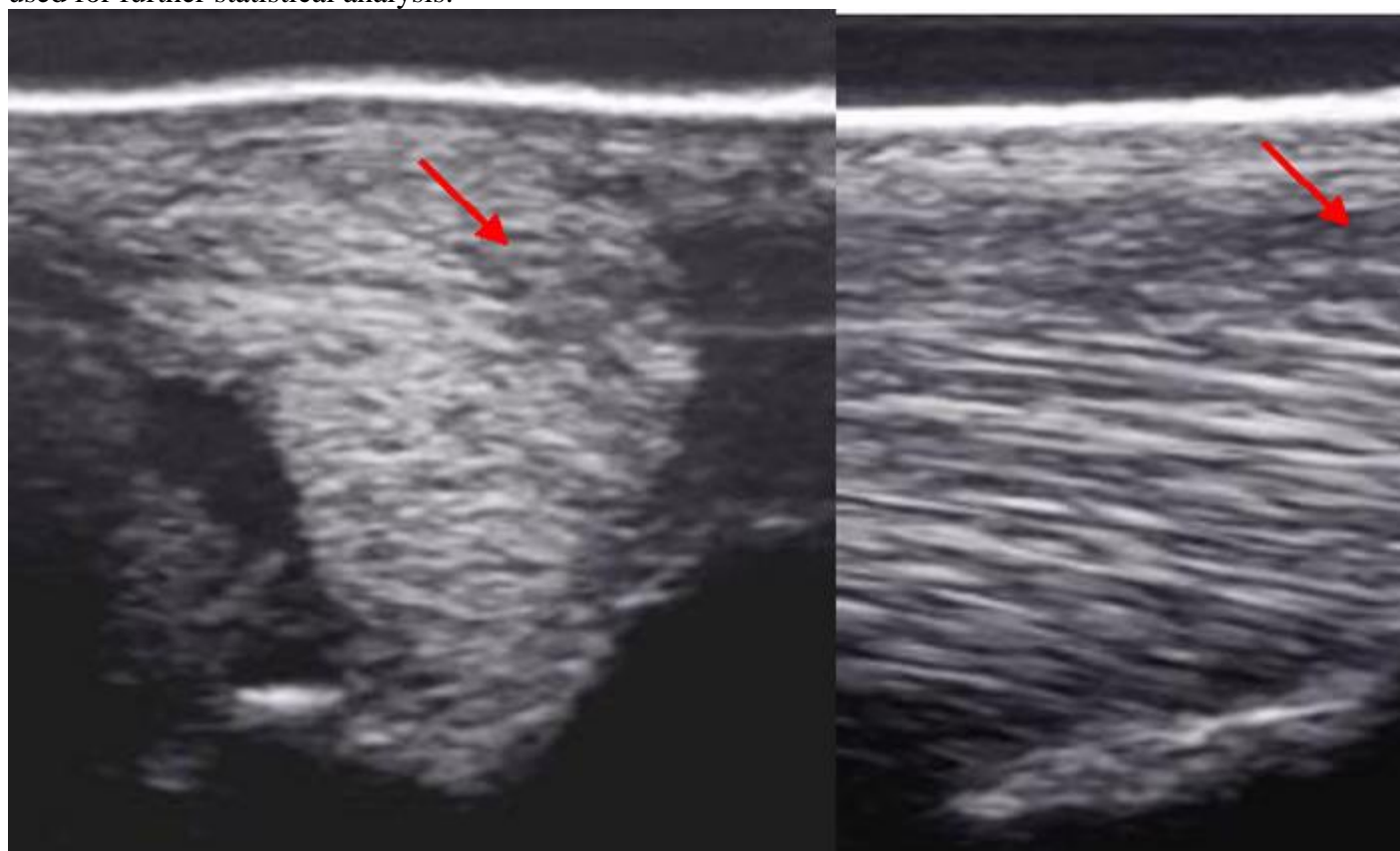


Figure 1.

Transverse and longitudinal images of a grade 1 suspensory ligament branch obtained at the insertion with an area of mild hypoechogenicity palmar–abaxially and reduced fibre pattern abaxially (arrows).

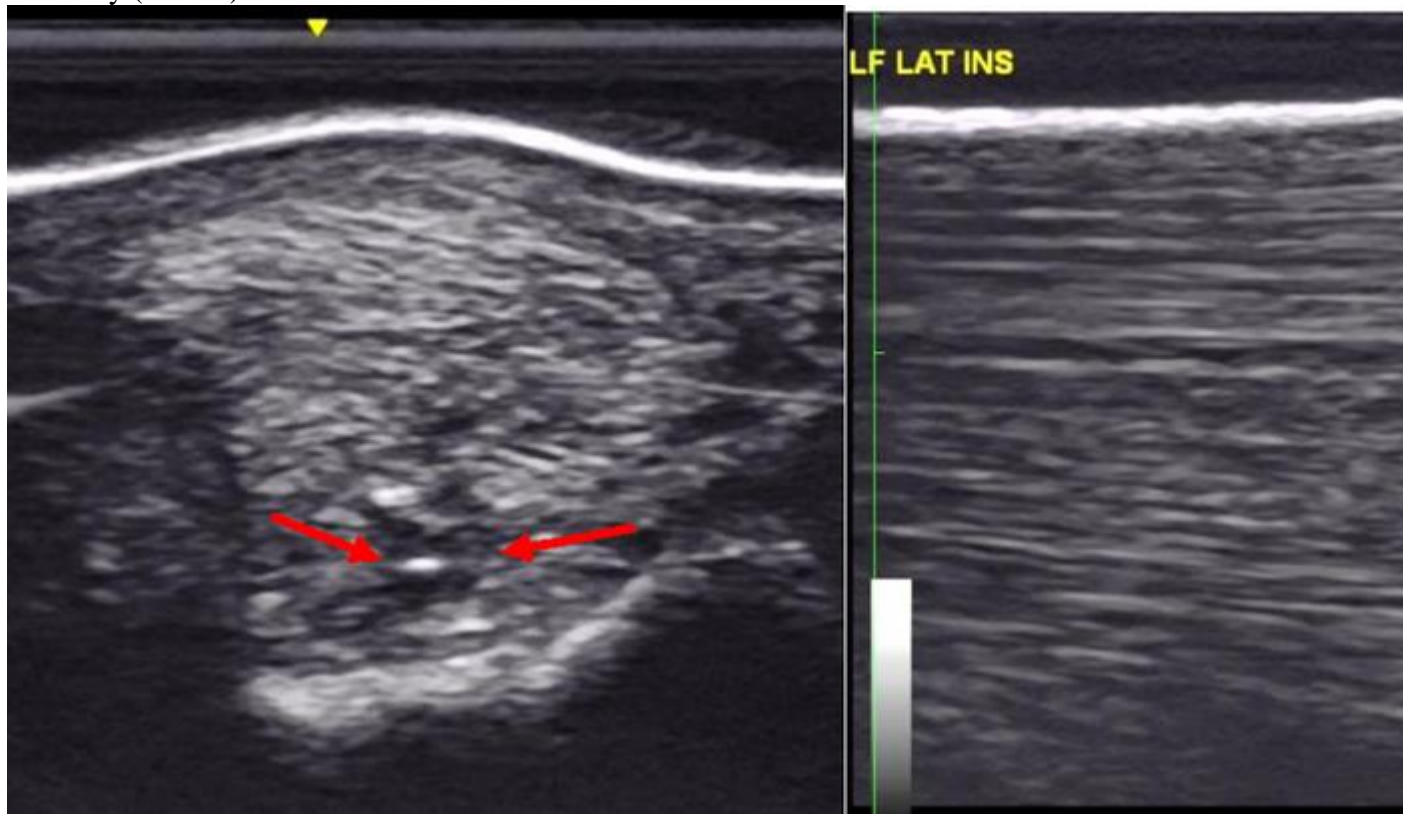


Figure 2.

Transverse and longitudinal images of a grade 2 suspensory ligament branch obtained at the insertion with an area of moderate hypoechogenicity and reduced fibre pattern centrally (arrows) and a fragment/mineralisation within the ligament at the insertion onto the proximal sesamoid bone (open arrow).

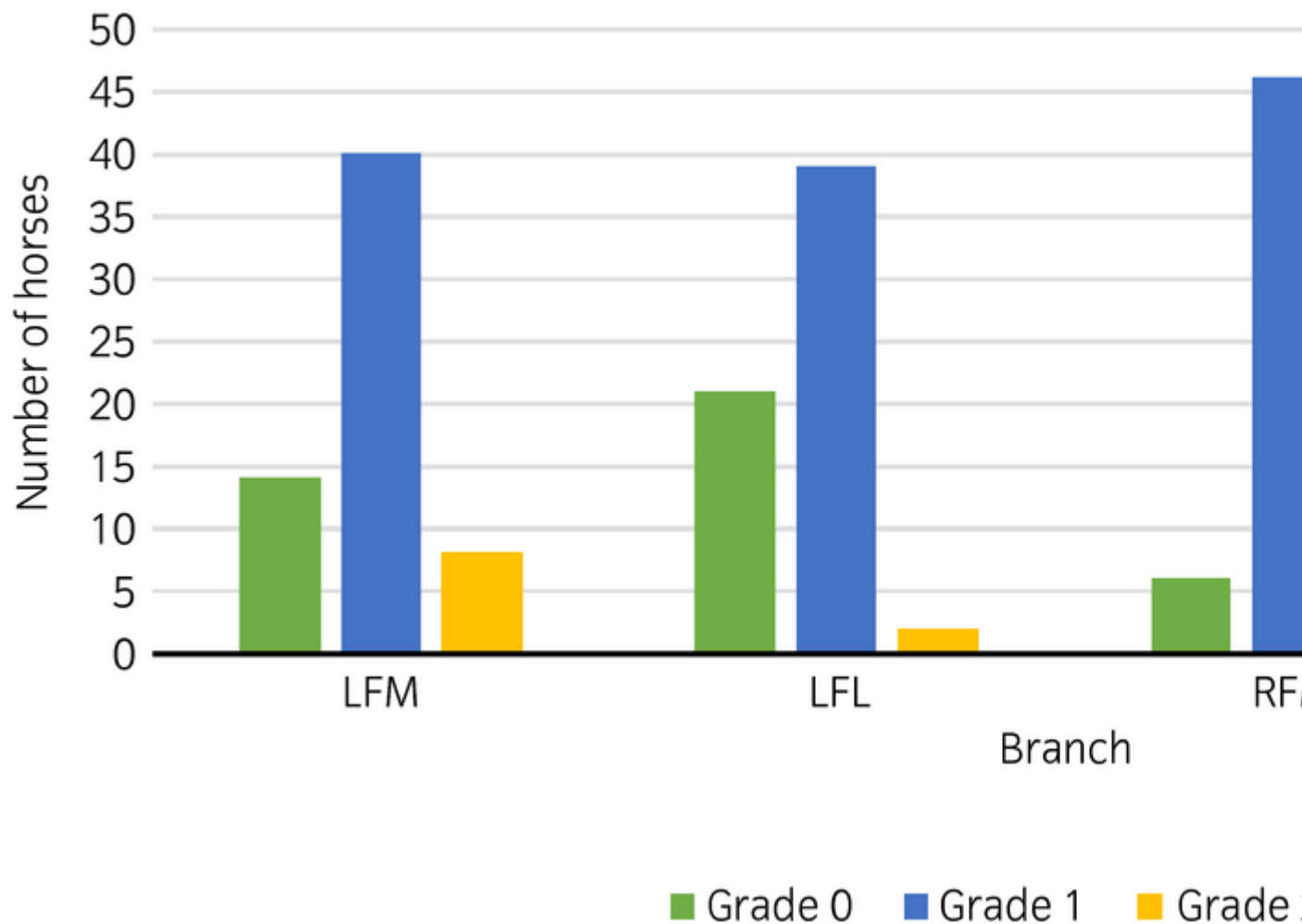


Figure 3.

Consensus grades assigned per suspensory ligament branch (SLB) in a population of 62 National Hunt racehorses without history or clinical signs of SLB injury. LFM, left forelimb medial; LFL, left forelimb lateral; RFM, right forelimb medial; RFL, right forelimb lateral.

All SLBs categorised as grade 2 had grade 2 abnormalities at the insertion (on either transverse or longitudinal images and in both in the majority [78%] of cases); in two branches grade 2 abnormalities were identified more proximally. The location of the grade 2 abnormalities was palmar–abaxial on the transverse images or abaxial/central–abaxial on the longitudinal images in almost all grade 2 SLBs. Grade 2 abnormalities were identified in the dorsal–axial location in two branches and centrally and axially in one each.

Of the consensus grade 2 SLBs, 19 of 62 (30.6%) horses had at least one grade 2 branch. Of these, 14 horses had one grade 2 branch, two had two grade 2 branches (both medial branches in each case) and three horses had three grade 2 branches (both medial branches and one lateral in all cases). All except one horse had at least one grade 1 branch abnormality. The distribution of grades between left and right limbs did not differ significantly for either the medial or lateral ($P > 0.05$ for both) branches and thus data for the left and right forelimb medial branches were pooled and compared against pooled data for the left and right forelimb lateral branches. The distribution of grades was significantly different between medial and lateral branches ($P = 0.002$) with significantly more grade 2 abnormalities in medial branches (18 of 27 consensus grade 2 branch abnormalities were medial) than in lateral branches ($P = 0.05$). The one

fragment identified was present in a grade 2 branch. No other significant associations were identified.

Cross-sectional area

Repeatability of CSA measurements was assessed; the coefficient of variation for each site was <3%.

The CSA data for the left forelimb medial branch were not normally distributed and were positively skewed; a square root transformation was applied to facilitate analysis. The results of the linear regression indicated there was no evidence of a significant association between the CSA of any branch and sex, age, height, weight, whether the horse was raced or unraced or number of career race starts ($P>0.05$). The CSA of the medial and lateral branches was significantly different in both the right and left forelimbs; the CSAs of the medial branches were significantly larger than those of the lateral branches in both forelimbs ($P<0.001$ for both limbs). The CSAs of the left and right forelimb medial branches were not significantly different and neither were those of the left and right forelimb lateral branches ($P>0.9$) (Table 2). There was no significant association between grade and CSA at the insertion of any branch and there was no significant difference in CSA between grade 0 and combined grades 1 and 2 branches ($P>0.05$).

Table 2. Mean cross-sectional areas (CSAs) of suspensory ligament branches (SLBs) in a population of 62 National Hunt racehorses with no history or clinical signs of SLB injury

Branch	Mean \pm s.d. CSA at insertion of SLB, cm ²
Left forelimb medial	1.420 \pm 0.156
Left forelimb lateral	1.281 \pm 0.132
Right forelimb medial	1.424 \pm 0.170
Right forelimb lateral	1.279 \pm 0.117

Follow-up

One horse developed lameness associated with moderate desmopathy of the left forelimb medial oblique sesamoidean ligament during the follow-up period; the left forelimb medial SLB had grade 1 changes at the time of initial scanning and was unchanged in appearance when re-examined by the same operator (AJF) at the time of this injury. No other horse developed an injury to the suspensory apparatus during the 8-month follow-up period.

Discussion

In this population of NH racehorses in training, 30.6% of horses had at least one SLB with grade 2 ultrasonographic abnormalities. The causes and significance of the ultrasonographic changes identified in the SLBs in this study are unclear. The changes may reflect previous SLB injury, although there was no known history of suspensory ligament injury in these horses. However, time on the yard (and therefore known history) was variable. NH horses will often have careers spanning several years and many will change trainers within their racing careers.

Although knowledge of the full veterinary history would be ideal for a study of this type and the lack of this information represents a limitation of the present study, this would be difficult to achieve in a relatively dynamic population. A recent study found palpation, even by an experienced clinician, to be inaccurate in the detection of SLB enlargement in comparison with ultrasonographic examination [4] and hence it is possible that palpation on the day of scanning and daily palpation by the assistant trainer may not have identified SLBs with clinical injury and that the ultrasonographic changes seen may therefore have resulted from mild active injury. Grade 2 changes were of a magnitude at which they may be considered ‘clinically significant’ to the horse [8], but all horses in this study were in fast work and were considered by the trainer to be fit to race at the time of scanning. In view of this, and the fact that no horse developed clinical injury (lameness/heat/swelling/pain on palpation) of the SLB in the season following scanning, it seems appropriate to classify the abnormalities detected as subclinical. A study using ultrasonography to assess SLBs in NH racehorses over several racing seasons would provide further information on these abnormalities in terms of progression and might help to determine their significance with reference to the development of clinical SLB desmopathy. Grade 2 abnormalities were significantly more likely to be identified in medial than in lateral SLBs, which is in agreement with both the study of subclinical SLB injuries in flat racehorses [8] and a recent post-mortem study of Californian racehorses that found that moderate lesions ‘purple and >2 mm in diameter’) were more common in the medial than the lateral SLB [9]. Biomechanical asymmetry in loading of the distal limb has been proposed as a possible cause for the medial over-representation in desmopathy of the collateral ligaments of the distal interphalangeal joint [18] and biomechanics may be a factor in the mediolateral distribution of SLB abnormalities in these racehorse populations. In contrast, medial and lateral SLBs were similarly affected in a study of clinical SLB desmopathy in a referral sport horse population [4].

The prevalence of horses with at least one grade 2 SLB in this study (30.6%) is considerably higher than the 6.7% previously reported in flat racehorses [8]. Several factors may contribute to this variation, including differences in age, training and racing between the two study populations. Many studies have established that prevalences of tendon and ligament injuries in racehorses increase with age [9-12, 19], possibly as a result of both cumulative exercise and age-related changes within the tendon matrix [20, 21]. The median age of the horses in the current study was 5 years, whereas the majority of horses in the flat racehorse population were 2-year-olds [8]. Although no significant effect of age on the presence of grade 2 abnormalities was detected within the present population, this may have related to the relatively low numbers of older horses in this study. Different trainers, or the different backgrounds of the two populations of horses (flat racehorses vs. horses mostly bred specifically for NH racing in the current population) may play a role in the difference in prevalences of SLB abnormalities; both factors have been found to affect the incidence of superficial digital flexor tendon injuries in NH horses [10]. Obviously the different sets of observers may have contributed to the difference between the two studies, although both studies used the same grading system and inter-observer agreement within each study was good. Both the current study and the study performed in flat racehorses [8] used static ultrasonographic images. This is a limitation of both studies; ultrasonographic assessment in real time has been found to be superior to assessment of static images [22].

Although there can be no histological confirmation of normal SLBs or those with desmopathy in a study of this type, grade 0 branches were considered in the present study to be ‘normal’. The fact that CSAs of normal SLBs did not differ significantly from those with ultrasonographic abnormalities may reflect the relatively mild nature of the ultrasonographic abnormalities seen or may suggest that CSA is a poor indicator of SLB injury. The CSA of the SLB in this population of horses is considerably larger than those reported in flat-racing

Thoroughbreds (80 mm²), Arabians (49 mm²) and Icelandic horses (66 mm²) [13, 15] and the normal range of 1.0–1.2 cm² quoted in a textbook [23]. This difference may in part reflect differences in the locations at which images were obtained, although all of the studies listed state that the branch was measured at the proximal aspect of the associated PSB. Alternatively, the increased size in the current population may be a function of adaptation to exercise, including jumping, or may be a further indicator of subclinical injury although the CSAs of grade 0 branches were very similar to those of branches with ultrasonographic abnormalities. The significant difference in CSA between medial and lateral SLBs was present in both forelimbs and applied when both grade 0 SLBs and all SLBs were considered. Increased size of the medial branch was found in a study of the CSAs of the palmar metacarpal soft tissues in purebred Spanish horses [14] and is noted in a textbook [23]. Other authors have not found significant differences in CSAs of medial and lateral SLBs [13, 15]. The reason for this difference is unclear, but it may reflect differences in the biomechanical forces acting across the limb from medial to lateral. This finding has implications for the clinical ultrasonography of SLBs because the comparison of the medial branch CSA with the lateral branch CSA may lead to misdiagnosis of medial enlargement.

Conclusions

In this population of UK Thoroughbred NH racehorses without a history or clinical signs of SLB injury, 30.6% were found to have at least one SLB with a grade 2 ultrasonographic abnormality. Further investigation is required to establish the significance and possible progression of these abnormalities, but the knowledge that ultrasonographic abnormalities within an SLB do not necessarily correspond to clinical signs of injury is important. The prevalence of grade 2 abnormalities in the NH horses in this study is higher than that previously reported in flat racehorses, but the medial over-representation of SLB abnormalities was similar. Further studies are required to establish whether this difference in prevalence is consistent between the two populations. The SLB CSA of the medial branch in this population was significantly larger than that of the lateral branch. The present authors therefore recommend comparison with the corresponding branch in the contralateral limb to avoid misdiagnosis of medial SLB enlargement.

Authors' declaration of interests

No competing interests have been declared.

Ethical animal research

This study was approved by the University of Bristol Animal Welfare and Ethical Review Body. Informed consent was obtained from the horses' trainer.

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Authorship

All authors were involved in study design. A.J. Fairburn acquired the images. A.J. Fairburn and A.R.S. Barr graded the images. A.J. Fairburn was responsible for analysis. All authors contributed to the preparation of the manuscript.

Manufacturers' addresses

www.racingpost.com.

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IBM Corp., Armonk, NY, USA.

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